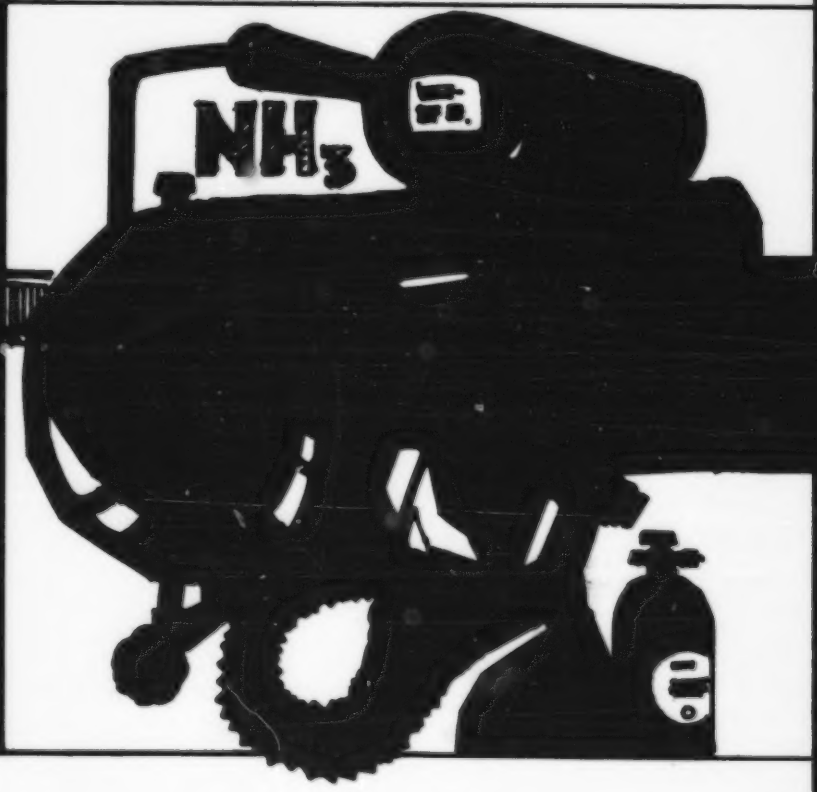
Refrigerant Safety in Ice Recreation Facilities



Alberta
COMMUNITY AND
OCCUPATIONAL HEALTH
Occupational Health and Safety Division

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GUIDELINES FOR THE HANDLING OF AMMONIA/FLUOROCARBON REFRIGERANTS IN PUBLIC RECREATION FACILITIES

FOREWARD

The contents of Guidelines for the Handling of Ammonia/Fluorocarbon Refrigerants in Public Recreation Facilities are intended for the purpose of accident prevention and should not be construed as legislation.

The suggested procedures are not intended to provide certified standards or to replace regulations published by government departments, boards or committees. The contents of this document state minimum practice only and cannot reflect detailed applications suitable for all facilities and conditions.

If you have any uncertainty as to the procedure required for a specific situation or facility, the expertise of the Occupational Health and Safety Division or the manufacturer should be solicited.

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I SCOPE

These procedures are intended:

a. to establish the minimum acceptable standard of practice for the operation and maintenance of ammonia and fluorocarbon refrigeration equipment and the safe handling of such equipment in public recreation facilities.

b. to define the educational needs for persons required to operate such equipment in public recreation facilities.

Definition of a competent worker:

"Competent," in relation to a worker, means adequately qualified, suitably trained and with sufficient experience to safely perform work that is the subject matter of the relevant section of these procedures, with or without only a minimal degree of supervision.

II TYPES OF REFRIGERANTS

A. Ammonia Refrigerant - General Information

1. **Physical properties** - Ammonia is a colourless gas with a strong pungent odour which may be detected at levels as low as 0.05 ppm. Liquid ammonia boils at atmospheric pressure at -33°C. The gas is lighter than air and very soluble in water.
2. **Toxic properties** - Gaseous ammonia is extremely irritating to the eyes, throat, nasal passages and skin. Although workers apparently develop a tolerance to ammonia, exposure to levels in the range of 5 to 30 ppm have been reported to cause eye irritation. Exposure to levels of 2,500 ppm produces permanent eye damage, breathing difficulties, an asthmatic-like upper respiratory tract spasm and chest pain. A potentially fatal accumulation of fluid in the lung may then develop some hours after exposure. Non-fatal poisoning may lead to the development of bronchitis, pneumonia and an impaired lung function.
   Skin exposure to levels of gaseous ammonia at very high levels produces skin irritation, skin burns and the formation of fluid filled blisters.
   Eye contact with liquid ammonia may lead to blindness and skin contact may lead to potentially fatal chemical burns.
3. **Flammability** - Ammonia is a flammable gas and forms potentially explosive mixtures with air in the range of 16% to 25% ammonia in air. Ammonia dissolved in water is not flammable.
4. **Chemical incompatibilities** - Ammonia reacts violently or produces explosive products with flourine, chlorine, bromine, iodine and some related chemicals. The reaction of ammonia with acids may generate considerable heat. Vapours of ammonia react with vapours of acid (HCL) to produce an irritating white smoke.
5. **Disposal** - Ammonia and ammonia-contaminated oil should be disposed of in a manner approved by local regulatory agencies. Discarding oil onto the ground or into sewer drains is not an acceptable practice.
6. **Exposure limits** - In most Canadian jurisdictions, the eight-hour exposure limit has been set at 25 ppm to protect workers accustomed to ammonia from experiencing eye or respiratory tract irritation. The 15-minute occupational exposure limit has been set at 35 ppm.

B. Fluorocarbon Refrigerant - General Information

There are several fluorocarbons in wide use as refrigerants today. Fluorocarbons are more commonly known by their trade

names: Freon, Arcton, Gentron, Isotron and Uron. Two of the more common products are chlorodifluoromethane (e.g. Freon-22) and dichlorodifluoromethane (e.g. Freon-12).

Although these refrigerants are not identical in performance and composition, they are part of the same basic family of chemicals. For the purposes of this description, we will deal with the most common: Fluorocarbon 22, often referred to by the trade name Freon-22.

Caution: Because of the diversity in the chemical make-up of each material, it becomes very important that the type of chemical being used is identified to ensure the proper safety methods and procedures are adhered to.

1. **Physical Properties** - Fluorocarbon 22 is an odourless, colourless gas, although it takes on an odour at concentrations above 20% in air. Liquid Fluorocarbon 22 boils at atmospheric pressure at -40°C. This gas is heavier than air and is water soluble, but some other fluorocarbons are not water soluble.
2. **Toxic Properties** - Acute toxicity is low at concentrations in air as high as 4% (40,000 ppm), but when oxygen levels in air are reduced to 17% ("normal" air contains 21% oxygen), symptoms of asphyxiation, loss of co-ordination, increased pulse rate and deeper respiration will occur. Skin exposure to the liquid can cause frostbite.
3. **Flammability** - This material is not combustible, but firefighters should use self-contained breathing apparatus, to protect against suffocation and possible toxic thermal decomposition, if this material is present in a fire situation.
4. **Chemical Incompatibilities** - This material is a stable gas under ordinary conditions of storage and use. It should not be exposed to alkali or alkaline earth metals such as sodium, potassium, barium, etc. High temperature decomposition can produce toxic and corrosive materials, such as HCl, HF, halogens and carbonyl halides. Phosgene gas and mustard gas can be produced if water is applied in a fire situation.
5. **Disposal** - Material to be disposed of should be returned to the vendor or to a licensed waste disposal company.
6. **Exposure Limits** - The maximum eight-hour exposure limit is 1,000 ppm. The 15-minute occupational exposure limit has been set at 1,250 ppm.
7. **Special Protection Information Because the Material is Heavier than Air** - Ventilation must meet the design standard. Special attention should be given to the ventilation of low lying areas (sumps, etc.) or smaller enclosures where this material might be used. High density of vapours may allow displacement of air and present possible asphyxiation hazards.

III FACILITY OWNER'S RESPONSIBILITIES

It is the facility owner's responsibility to ensure that the safety requirements for an ammonia or fluorocarbon refrigerant plant are adhered to. These safety requirements include:

a. 1. The development of a written emergency procedures plan, specific to each facility, including: leak handling procedures and evacuation procedures (Section IV).

   2. As part of this plan, the owner will ensure written contact is made with local fire and police authorities in order to ensure a mutual understanding exists regarding:
      - type and volume of refrigerant,
      - relief valve location,
      - remote shut-down location,
      - vent location, and
      - alarm activation point

b. The provision and servicing of adequate safety equipment (Section V).

c. The adherence to proper maintenance procedures (Section VII) and to a basic preventive maintenance program (Section VIII).

d. The training of operating personnel in:
   1. emergency procedures,
   2. use of safety equipment,
   3. emergency first aid,
   4. proper maintenance procedures, and
   5. preventive maintenance.

IV EMERGENCY PROCEDURES

Emergency Leak Assessment Procedures

The operator/manager discovering a leak in the refrigeration system must immediately assess the severity of the emergency by:

1. Determining the concentration of the refrigerant in the affected areas: a trace; a minor concentration; a major concentration.
2. Determining the degree to which public/staff safety is affected and implementing the Emergency Evacuation Procedures as required.
3. Determining the nature of corrective action required, or call in competent personnel to assess the corrective action required.

Emergency Evacuation Procedures

1. Remain calm.
2. Sound emergency alarm (e.g. fire alarm) and close the refrigerant room door to help contain the leak.
3. Telephone appropriate emergency agency (fire, police, ambulance, supplier) stating: facility address and nature of problem.
4. Evacuate everyone in the facility through the nearest safe exit, avoiding the source of the problem (fire, noxious gases).
5. Conduct a systematic search of the building, if it is safe to do so.
6. Contact facility supervisor.
7. Upon their arrival, direct emergency personnel to the source of the problem.
8. Contact the Occupational Health and Safety office nearest your area:

Calgary	297-2222
Edmonton	427-8848
Fort McMurray	743-7202
Grande Prairie	538-5249
Vermilion	853-8140
Lethbridge	381-5522
Medicine Hat	529-3530
Red Deer	340-5170

V SAFETY EQUIPMENT REQUIREMENTS

A. **Warning Signs**
   1. Appropriate signage relative to worker/public safety shall be posted.
   2. Recommended signs: "Ammonia Hazard, Authorized Personnel Only" or "Fluorocarbon Hazard Authorized Personnel Only".
   3. Recommended size: 46cm x 46cm (18" x 18") minimum.
   4. Recommended colours: red lettering on white background.
   5. Posted at every entrance to refrigeration room (exterior of door).
   6. Posted doors shall remain closed at all times, but operable in case of emergency.

B. **First Aid Kit** (one per installation)
   1. Industrial kit
   2. Sealed irrigation bottle of sterile water (should be changed frequently)
   3. Sterile dressings
   4. Wool blankets (2)

C. **Protective Clothing**
   All exposed skin must have sufficient covering. Leaking refrigerants may cause burns, in the case of ammonia, and major leaks of compressed gases may cause severe frostbite.

D. **Respiratory Protection**
   1. Canister type, full-face mask respirator with spare canisters, for maintenance and escape purposes.
   2. A self-contained, positive pressure breathing apparatus (S.C.B.A.) for emergency procedures. The S.C.B.A. must have a 30 minute approved air supply, low pressure alarm, full face piece and positive pressure demand type two-stage regulator. This equipment must be located near, but not in the refrigeration room (in an area not likely to be affected by contamination).

E. **Ammonia/Fluorocarbon Detection Device**
   1. The detection device must be located near, but not in the refrigeration room (in an area not likely to be affected by contamination), with a remote sensor located in the refrigeration room.
   2. Complete with audible alarm and visible alarm. Visible portion of alarm to be installed in the arena proper.
   3. Ammonia Detection Devices:
      — It is suggested that two-stage alarms be employed. The alarm activation point for the first stage shall not exceed 10 ppm. The alarm activation point for the second stage shall

not exceed 25 ppm.
- — if single-stage alarms are employed, the alarm activation point shall not exceed 25 ppm.

4. Fluorocarbon 22 Detection Devices:
   - — The alarm activation point shall not exceed 1,000 ppm.
   - — As an alternative to fluorocarbon detection devices, the operation of mechanical ventilation for two minutes prior to entry into the refrigeration room may be acceptable.

F. **Fire Extinguishers**
Type, size and number to comply with fire code.

G. **Storage of Refrigerant**
Spare cylinders of refrigerant must be secured in an upright position in the refrigeration room.

VI FIRST AID

Ensure that all emergency equipment is readily available and kept in proper operating condition.

A. **Gas Inhalation**

1. Don protective equipment and remove affected personnel into fresh air immediately.
2. Summon rescue/medical personnel.
3. Remove clothing if splashed with liquid or impregnated with concentrated vapour and flush with water for a minimum of 15 minutes.
4. Keep the patient still and warmly wrapped with blankets.
5. If conscious and the mouth is not burnt, give hot, sweet tea or coffee.
6. Oxygen may be administered by a person trained to do so.
7. If breathing fails apply cardiopulmonary resuscitation.

B. **Liquid Splashes/Concentrated Vapour**

1. Irrigate eyes **immediately** with a solution of sterile water (or if not available, tap water), move patient to water supply and continue irrigation for at least 30 mintues.
2. Summon medical personnel.

C. **Skin Burns**

On skin burns from liquid splashes or concentrated vapours:

1. Flush immediately with copious amounts of water (shower) for at least 15 minutes, removing all clothing while washing.
2. Contact medical personnel.
3. After washing, apply clean wet compresses to affected parts until medical advice is available.

D. **Ingestion**

Ingestion is improbable due to the extreme temperature of the material. If ingestion does occur, drink copious amounts of water and do not induce vomiting.

VII MAINTENANCE PROCEDURES

A. **Ammonia Refrigeration Plants**

1. Start Up and Shut Down procedures should only be carried out by a competent worker.
2. Daily Maintenance - a plant inspection should be conducted a minimum of twice per day and include:
   - read, record and compare to manufacturer's specifications:
     - brine temperature
     - suction pressure
     - discharge pressure
     - discharge temperature
     - oil pressure
     - oil level
     - refrigerant level
     - brine level
     - compressor hour meters
     - outside temperature
   - add oil to compressor, if required (see following procedure)
   - drain oil from brine chiller tank, if required (see following procedure)
   - clean oil filter(s)
   - check belt tensions (ensure equipment is locked out)
   - check couplers (visual and audible inspection)
   - check condenser fan operation
   - check condenser pump operation
   - check brine pump operation
   - ensure safety guards are in place prior to any operation
   - initial log upon completion of inspection
3. Procedure for Adding Oil to Compressor:
   - ensure pump has an adequate oil supply
   - attach oil supply hose to compressor
   - open valve and add oil to level recommended by the manufacturer (normally 1/3 of site glass)
   - close valve
   - ensure oil supply is sealed
   - record amount of oil added in the plant inspection log
4. Procedure for Drainage of Oil from Brine Chiller Tank:
   - this task should only be performed by a competent worker.
   - the need to drain oil is evidenced by a lack of frost on the lower portion of the oil pot/pod located on the bottom of the chiller. The amount of oil that can be allowed to accumulate before drainage is necessary will be determined through experience.

- if possible, the oil should be drained when there are no members of the public in the facility. Prior to draining oil the worker shall inform either his supervisor or a co-worker as to the nature and schedule of the work to be performed.
- prior to entering the refrigeration room, ensure the lighting and ventilation systems are functioning. The door should be secured in the open position when the room is occupied.
- worker doing the bleeding down shall wear at least a full face mask respirator with 3% cannister and gauntlet type gloves. If a leak should be detected by the worker he will, if practical, close the drain valve and evacuate the room immediately, closing the door to control the fumes. Emergency personnel should be summoned before any re-entry into the room.
- open the valve(s) in a manner which will allow only the slow release of oil/oil foam from the chiller. Once the valve is opened, some time may be required for the foam to exit.
- drain the oil/oil foam into a container of water through a transparent hose or tube which is immersed below the water surface.
- observe the flow of oil/oil foam through the tube. Close the valve(s) once the ammonia gas forces the oil foam from the tube. Close the valve(s) immediately upon observing any escaping ammonia gas.
- at no time should the open valve be left unattended. (The worker's hand shall remain **on** the valve throughout the procedure.)
- return respirators to their proper location and service as required.

B. **Fluorocarbon Refrigeration Plants**

1. Start Up and Shut Down procedures should only be carried out by a competent worker.
2. Daily Maintenance - a plant inspection should be conducted a minimum of twice per day and include:
   - read, record and compare to manufacturer's specifications:
     - brine temperature
     - suction pressure
     - discharge pressure
     - oil pressure
     - oil level
     - refrigerant level
     - brine level
     - compressor hour meters
     - outside temperatures

- add oil to compressor, if required
- clean filter(s)
- check belt tensions (ensure equipment is locked out)
- check couplers (visual and audible inspections)
- check condenser fan operation (check for short cycling)
- check condenser pump operation
- check brine pump operation
- ensure safety guards are in place prior to any operation
- initial log upon completion of inspection

C. For items not sepcifically referenced in this booklet the manufacturer's specifications for maintenance should be followed.

VIII BASIC PREVENTIVE MAINTENANCE

A. **Inspection Log**
Maintain the daily operating log. Analyze these recordings each day. When they differ from design or established limits, determine the cause and make corrections immediately. Record all repairs, changes, additions and adjustments. This applies to items done on a routine basis, as well as to those done on a scheduled or emergency basis.

B. **Relief Valves and Safety Controls**
Each relief valve and safety control should be tested each year in accordance with the Alberta Boilers and Pressure Vessels Act.

C. **Vessels and Piping**
All vessels and piping should be maintained in a clean and painted condition. Do not paint valves or controls as they may become sealed and inoperable. Do not allow personnel to stand upon equipment when performing maintenance duties. Repair insulation as required. Piping should be colour coded (B-52 Code).

D. **Lubricants**
The use of lubricants shall be restricted to the type recommended by the manufacturer.

E. **Condensers**
1. Evaporative:
Maintain the correct water treatment if such is employed. It is recommended that the exchangers be descaled as required. The clear operation of the sprays should be verified monthly. Maintain belts and pulleys per the manufacturer's recommendations. Ensure fan guards are in place. Ensure that a source of condenser make up water is supplied and is at least equal to the amount of evaporation. Check exchanger surface. Clean as required.
2. Air Cooled (most fluorocarbon plants):
Check exchanger surface. Clean as required. Ensure fan guards are in place.

F. **Cleanliness**
Keep all equipment and the refrigeration room floor clean. Any clutter or tripping hazards should be removed from the room and adjacent hallways to ensure safe access and egress. An annual painting of all surfaces will assist in the maintaining of a clean work area.

G. **Electrical**
It is desirous to have the electrical installation checked, and serviced if necessary, on an annual basis.

H. **Compressors**
Overhauls, both top and bottom, should be carried out at the manufacturer's specified intervals. Hour meters are desirable in determining the need for overhauls.

IX DESIGN CONSIDERATIONS

Code	Coverage
CSA B52-M1983	— Mechanical Rooms and Equipment
ANSI A13.1-1981	— Pipe Identification
ASME 31.5	— Piping

A. Class T - refrigeration compressor rooms. By definition of B-52 they require (ammonia only):
   1. Continuous ventilation (i.e. fan running constantly). For a normal 60-ton plant containing approximately 1,000 lbs of ammonia a ventilation rate of 2,050 CFM is required, or
   2. Intermittent ventilation (i.e. vent system) at prescribed rate, brought on by an ammonia detection system at a preset ammonia level complete with remote alarm.
   3. Class I, Division 2, required if neither of the above is done. This is primarily explosion proof equipment.
   4. All basement rooms to have continuous ventilation.

B. Gauge glass protection - it is **mandatory** that gauge glass be protected with metal shields if not incorporated in the vessel.

C. All systems to be equipped with relief lines vented externally above roof edge or at least 5 metres above ground level. Vents must be a minimum of 8 metres away from exhaust, intake louver, window or door access.

D. An emergency basis, remote shut down switch for the compression system is required. This is located in a fire box external to the refrigeration room, on the outside wall and easily accessible to fire department personnel. It contains an emergency dump line valve to expell refrigerant.

E. Oil drainage - For new construction, and to prohibit serious leakages, the design shown in Appendix 1 shall be installed. Clear access to the oil drain should be ensured, and the area should be free of clutter.

F. Open Flames - For new construction, appliances and refrigeration rooms must comply with the Provincial Gas Code.

G. Open Flames - For existing construction, gas fired appliances need not be removed if:
   — an ammonia detection device is operational. This detection device must activate the mechanical ventilation and a remote alarm, and
   — the mechanical ventilation system is sized according to Table 7.1 of the CSA B52-M1983 "Mechanical Refrigeration Code" (see Appendix 2).

NOTE: in future upgrading consider the replacement of gas fired appliances.

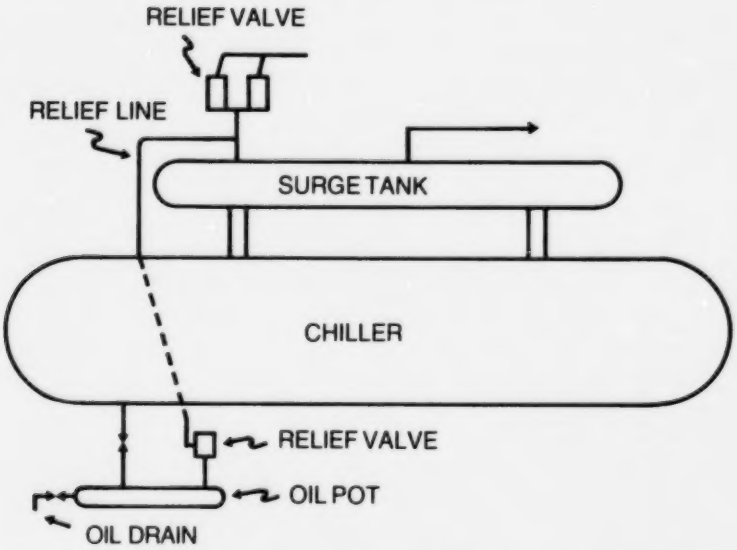
H. Panels (electrical) and disconnects should be provided with lock-out clamps. Each system that is not should provide for electrical safety procedures and include the "buddy" system.

I. Minimum lighting requirements should be established. As well, emergency lighting is mandatory. A standard of a minimum of 50 foot candles, 1 metre off the floor is desired.

J. Layout design should require a minimum of 1 to 1.5 metres between access points to valves and controls to accommodate egress.

APPENDIX 1

OIL DRAINAGE DESIGN



Oil Drain - Note: Oil must be drained through a clear hose into a container of water and with the hose exit submerged.

NOTES:

1. Oil pot additions are highlighted.
2. Pot, valve, line sizing determined by size of chiller.
3. Electric heater may be used in pot to warm oil.

APPENDIX 2
MINIMUM VENTILATION REQUIREMENTS

	WEIGHT OF REFRIGERANT		MECHANICAL DISCHARGE OF AIR		WEIGHT OF REFRIGERANT		MECHANICAL DISCHARGE OF AIR,Q	
	lb	(kg)	cfm	(l/s)	lb	(kg)	cfm	(l/s)
to	20	(9)	150	(71)	5000	(2268)	5500	(2596)
	50	(23)	250	(118)	6000	(2722)	6300	(2973)
	100	(45)	400	(189)	7000	(3175)	7200	(3398)
	150	(65)	550	(260)	8000	(3628)	8000	(3775)
	200	(90)	650	(321)	9000	(4052)	8700	(4106)
	250	(113)	800	(378)	10000	(4536)	9500	(4483)
	300	(136)	900	(425)	12000	(5443)	10900	(5144)
	400	(180)	1100	(519)	14000	(6530)	12200	(5757)
	500	(226)	1275	(602)	16000	(7528)	13300	(6277)
	600	(272)	1450	(684)	18000	(8165)	14300	(6748)
	700	(318)	1630	(769)	20000	(9072)	15200	(7173)
	800	(363)	1800	(849)	25000	(11340)	17000	(8023)
	900	(408)	1950	(920)	30000	(13608)	18200	(8589)
	1000	(454)	2050	(967)	35000	(15876)	19400	(9155)
	1250	(567)	2250	(1062)	40000	(18144)	20500	(9674)
	1500	(680)	2500	(1180)	45000	(20412)	21500	(10146)
	1750	(794)	2700	(1274)				
	2000	(907)	2900	(1369)				
	2500	(1134)	3300	(1557)				
	3000	(1360)	3700	(1746)				
	4000	(1814)	4600	(2171)				

This booklet was produced as a result of a co-operative effort by the Alberta Association of Recreation Facility Personnel, Alberta Recreation and Parks, Alberta Community and Occupational Health, and Refrigeration Industry Representatives.